TASS Signal Specification

Completed Technology Project (2015 - 2016)

Project Introduction

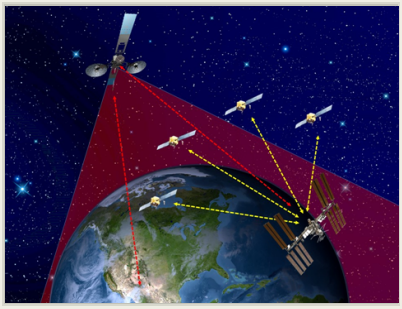
The Tracking Data Relay Satellite System (TDRSS) Augmentation Service for Satellites (TASS) is a unique mission enabling service that could be provided by the current Space Network (SN) or the future Space Mobile Network (SMN). TASS will provide a global S-band beacon to disseminate global GPS differential corrections, GPS constellation status, Earth orientation parameters, space weather alerts, low rate forward commands, TDRS ephemeris, and a GPS compatible radiometric source to allow missions that receive TASS to improve the accuracy and reliability of on-board navigation and to allow for automation of many aspects mission operations. To date, work remains to finalize the TASS signal specification and to develop the necessary software/firmware to receive and process the signal.

Preliminary development of the TASS system concept and design included establishing mature ICDs with the various data sources, developing a TASS Data Integrator (TDI) unit to subscribe and collate the various data into the TASS message, and to combine the GSFC Navigator GPS receiver firmware with Space Network compatible TDRSS transponder firmware in a single FPGA platform.

This FY16 IRAD will build on the current success to further develop the end-to-end TASS system by meeting the following objectives:

1. Execute a dynamic TASS link budget in order to finalize the TDRS MAF spoiled beam configuration and determine the maximum achievable data rate on the TASS beacon
2. Finalize I/Q power ratio choice to enable weak-signal (low E_S/N_0) tracking necessary for exploitation of the TASS LDPC ½ error correcting code as well as enabling fast-acquisition of TASS signal, either via command channel (I) or dataless pilot channel (Q)
3. Finalize code division multiple access (CDMA) spreading codes as part of the TASS signal specification. Demonstrate suitable auto correlation properties and cross correlation properties against NASA CDMA (SNIP) codes
4. Design and code (in software or firmware) appropriate circular correlation or massively parallelized acquisition scheme to acquire TASS signal with zero a-priori information (no Doppler aiding or forward Doppler compensation)
5. Use software radio device to modulate TASS signal at desired RF frequency in lab (2106.4 MHz)
6. Use software radio device to demonstrate acquisition engine performance over a range of incident C/N_0s and dynamics

Finalization of the TASS signal specification is necessary to proceed with further development of TASS. Once the GPS and TDRSS firmware is integrated into a common platform, the next step will be modification of the TDRSS waveform to both receive the TASS signal and to process the TASS data



Conceptual image of on-orbit reception of TASS beacon and GPS signals on the International Space Station (ISS).

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message. At the end of this FY16 IRAD, the TASS system (including both ground and user elements) will be considered TRL6.

This work is applicable to the S-band (2.0 to 2.2 GHz) forward and return space-to-space spectrum allocations held by NASA.

Anticipated Benefits

TASS, or a similar beacon service, will provide fundamental functions of the Space Mobile Network. The ability for users to reliably and accurately navigate autonomously is necessary for implementation of User Initiated (unscheduled, on-demand) Services, known as UIS; autonomous navigation and the exchange of self-generated state information will allow for pointing of laser communication terminals from the user spacecraft to laser ground terminals or a laser relay.

TASS also provides a channel for unscheduled forward commanding of users within the beacon coverage area to allow the UIS protocol to negotiate on-demand high rate service for science data delivery. Acknowledgement of service requests and then communication of service fulfillment will be executed using commands transmitted via the TASS beacon. Combined with the MA return Demand Access System (DAS), the current TDRS spacecraft could provide a ubiquitous, low to moderate data rate, on demand, TT&C capability.

Finally, TASS is a complementary navigation service to GPS that provides navigation performance enhancements for high accuracy users and an independent source of position, navigation, and timing (PNT) for users who desire resiliency.

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

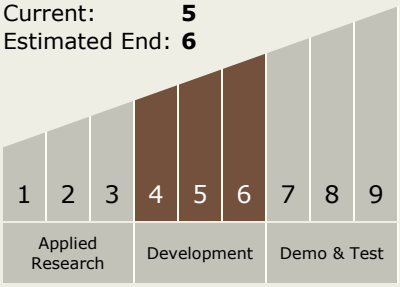
Dennis W Woodfork

Principal Investigator:

Jennifer E Donaldson

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **6**



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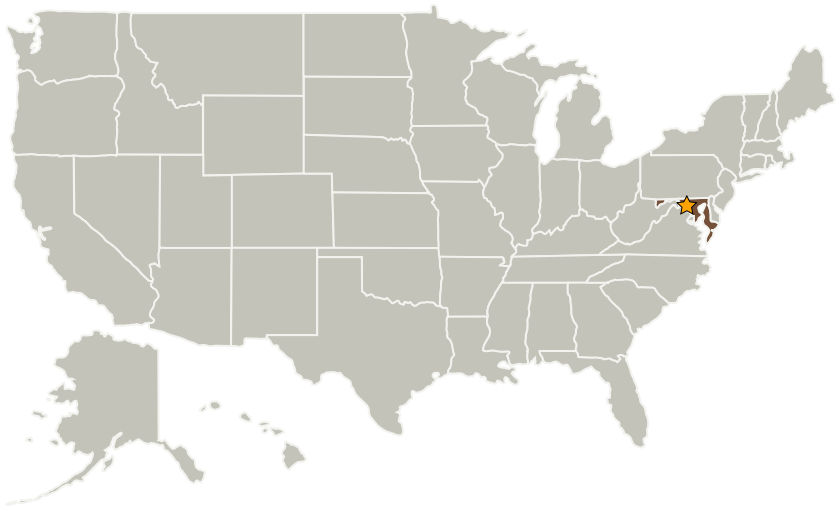
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Technology Areas

Primary:

- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
  - TX05.4 Network Provided Position, Navigation, and Timing
    - TX05.4.2 Revolutionary Position, Navigation, and Timing Technologies

Other/Cross-cutting:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.2 Navigation Technologies
    - TX17.2.4 Relative Navigation Aids

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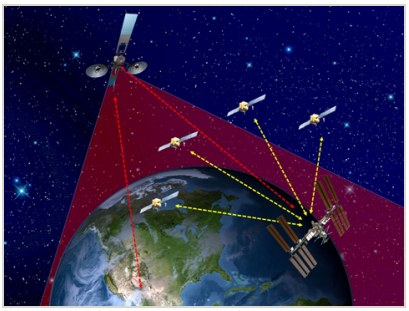
Images



TASS Beacon
Conceptual image of on-orbit reception of TASS beacon and GPS signals on the International Space Station (ISS).
(https://techport.nasa.gov/image/19100)